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An analysis of radiating pain at lumbar discography

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Abstract This study aimed to identify the morphological abnormalities of the intervertebral disc, as demonstrated by lumbar discography, that are associated with pain radiation to the hip, groin, buttock or lower limb. We carried out a retrospective review of 99 consecutive lumbar discogram reports. The association of disc degeneration, annular tears (partial or full thickness) and the level of disc injected was determined with respect to the presence and pattern of radiating pain. A total of 260 discs were injected, of which 179 were considered abnormal. Posterior annular tears were demonstrated in 84 discs, anterior annular tears in 15 discs and 45 discs had both anterior and posterior tears. A significant association was identified between isolated posterior tears and the production of concordant radiating pain (P = 0.0041). No difference was identified between partial thickness posterior tears and full thickness posterior tears associated with leak of contrast medium, with regard to radiating pain. Similarly, there was no significant association between disc level injected and the pattern of pain radiation. The results indicate that pain experienced in the buttock, hip, groin or lower limb can arise from the posterior annulus of the intervertebral disc without direct involvement of the nerve root.

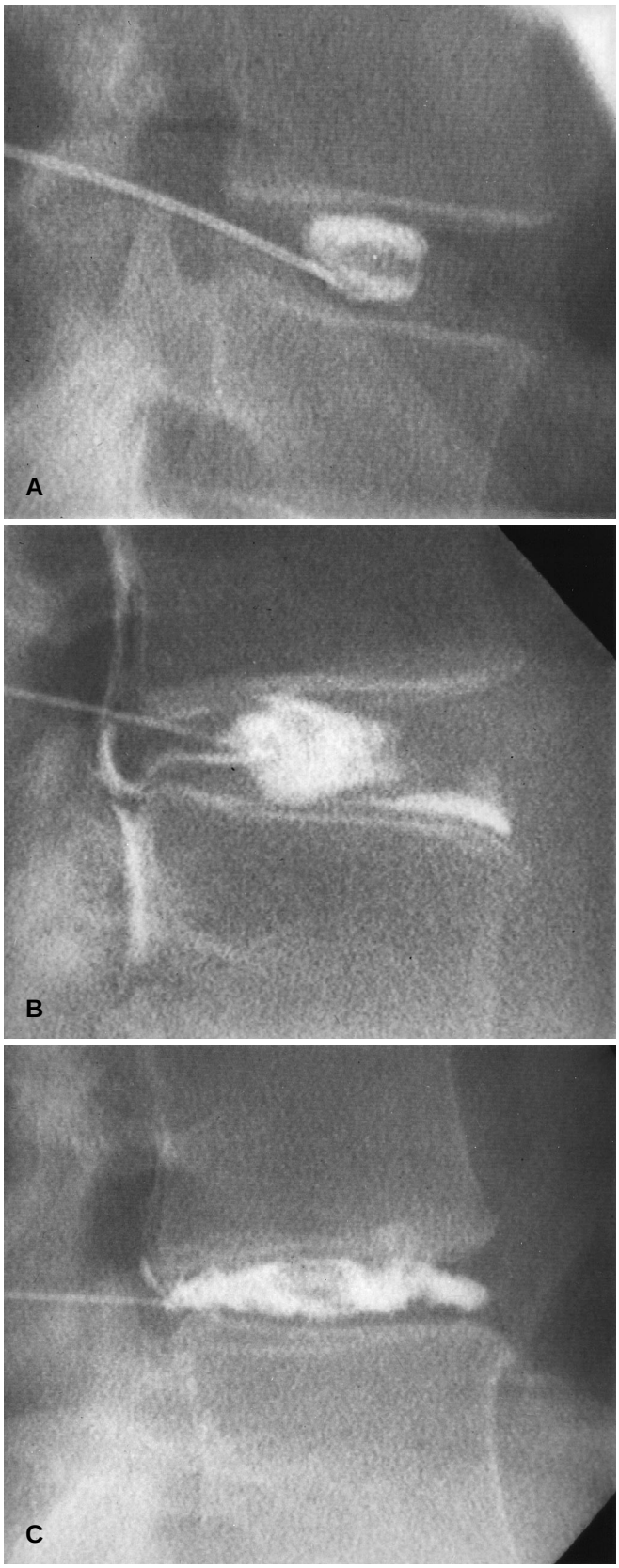
Key words Low back pain · Radiculopathy · Discography · Intervertebral disc

Introduction

Low back pain with radiation into the lower limb is a common clinical complaint. Imaging studies frequently show absence of nerve root compression [9] and it has been suggested that the origin of such referred pain lies within the intervertebral disc itself. Crock introduced the concept of 'internal disc disruption', suggesting that chemical alterations within the nucleus pulposus of a degenerative disc could result in both back pain and lower limb pain [2, 3]. The aim of the present study was to identify pathological features of the intervertebral disc, as demonstrated by discography, that were associated with concordant pain radiation.

Materials and methods

The study consisted of a retrospective review of lumbar discography reports of 99 consecutive patients. All patients were referred for discography by a single spinal surgeon over a period of 30 months for the investigation of chronic low back pain, with or without radiating pain, as a precursor to spinal fusion. The study group comprised 52 males and 47 females with a mean age of 43.3 years (range 22–69 years). MRI prior to discography excluded the presence of nerve root compression. All discograms were performed by a single radiologist using a posterolateral injection technique. Non-ionic contrast medium was injected through a single 18-G needle until there was either a firm end-point to the injection, or until pain was provoked, or to a maximum of 5–6 ml. For each disc injected, the following features were recorded: (1) nuclear morphology, (2) presence and site of annular tears and (3) patient response (no pain, concordant back pain, concordant radiating pain into the buttock, hip, groin or lower limb, or non-con-



cordant pain). The various discographic abnormalities are illustrated in Fig. 1. Response to discography was recorded at the time of each disc injection by direct questioning of the patient. For the purposes of this study, concordant pain (defined as severe pain that was either very similar to or totally reproduced the patient's symptoms) was the most important criterion for a positive discogram. The association between various discographic findings and reproduction of symptoms was investigated by Fisher's exact test and chi-squared analysis.

Results

A total of 260 discs were injected at discography. Table 1 documents the relevant discographic features and patients' response to disc injection. A highly significant association was identified between annular tears and both concordant back pain (Table 2) and radiating pain of any type (Table 3). A significant association between isolated posterior annular tears and pain radiation was demonstrated (Table 4), whereas isolated anterior annular tears were not associated with pain radiation.

No significant difference was identified between full thickness posterior annular tears and partial thickness posterior annular tears with regard to the reproduction of radiating pain (Table 5). Table 6 documents the relationship between level of disc injected and pattern of radiating pain. Although there was an increased incidence of leg pain compared to groin, buttock or hip pain with injection of the L4/5 and L5/S1 discs, this did not reach statistical significance.

Discussion

Several studies have indicated that direct involvement of a nerve root is not necessary to produce sciatica. McCutcheon and Thompson [6] demonstrated a relationship between posterolateral radial tears of the annulus on CT discography and the reproduction of ipsilateral leg pain. Milette et al. [7] showed that leg pain reproduced at discography could be partially or completely abolished by the intradiscal injection of local anaesthetic. Ohnmeiss et al. [12] demonstrated a significant relationship between symptomatic grade 2 and grade 3 annular disruptions as shown in CT discography and the presence of extremity

Fig. 1 A–C Classification of discographic findings. **A** Normal disc showing typical 'hamburger' sign of the nucleus with an intact annulus. **B** Abnormal disc showing early nuclear degeneration manifest as extension of contrast medium beyond the normal confines of the nucleus. However, differentiation of the nucleus and annulus is still possible. There is a full thickness posterior annular tear with leak of contrast medium which collects deep to the posterior longitudinal ligament. There is also a partial thickness anterior annular tear. **C** Abnormal discogram showing severe disc degeneration (SDD) manifest as complete loss of differentiation between the nucleus and annulus. There is generalised circumferential disruption of the annulus. A distinct anterior or posterior annular tear is not identified

Table 1 Summary of discogram findings (*DD* degenerate disc, *AT* anterior annular tear, *PT* posterior annular tear, *SDD* severe disc degeneration, *G*/*H*/*B* groin/hip/buttock, *conc* concordant, *rad* radiating)

Disc level	Number injected	Discogram findings						Patient response				
		Normal	DD&AT	DD&PT	DD&AT &PT	SDD	Posterior leak	No pain	Non-conc pain	Conc back pain	Conc rad pain	
											G/H/B	Leg
L1/2	6	1	1	1	1	2	2	1	0	5	1	1
L2/3	36	14	3	8	8	3	11	14	5	14	6	3
L3/4	85	36	8	20	17	4	26	36	8	42	12	10
L4/5	92	24	2	37	16	13	35	30	7	56	7	19
L5/S1	41	6	1	18	3	13	15	6	5	29	9	14
Total	260	81	15	84	45	35	89	87	25	146	35	47

Table 2 The relationship between annular tears (AT) and concordant back pain

	Conc back pain		
	No	Yes	Totals
No AT	78	3	81
AT	36	143	179
Totals	114	146	260

Fisher's exact *P*-value < 0.0001

Table 3 The relationship between annular tears and concordant radiating pain (all types)

	Conc radiating pain		
	No	Yes	Totals
No AT	80	1	81
AT	102	77	179
Totals	182	78	260

Fisher's exact *P*-value < 0.0001

Table 4 The relationship between isolated annular tears (anterior/posterior) and concordant radiating pain (all types)

	Conc radiating pain		
	No	Yes	Totals
Ant. tear only	14	1	15
Post. tear only	46	38	84
Totals	60	39	99

Fisher's exact *P*-value = 0.0041

Table 5 The relationship between posterior leak and concordant radiating pain when posterior annular tear is present (*HGB* hip, buttock or groin pain)

	Concordant radiating pain			
	None	Leg	HBG	Totals
No posterior leak	39	21	13	73
Posterior leak	49	22	17	88
Totals	88	43	30	161

Chi square = 0.298
Chi square *P*-value = 0.8616
(Note: Three cases where combined leg and HBG pain occurred were excluded to permit Chi square analysis)

Table 6 The relationship between level of disc injection and presence and type of concordant pain (in *abnormal* discs)

Disc level	G/H/B		Leg	
	No	Yes	No	Yes
L1/2	4	1	4	1
L2/3	16	6	19	3
L3/4	38	11	39	10
L4/5	61	7	49	19
L5/S1	26	9	21	14
Total	145	34	132	47
Chi Square	5.736		6.290	
P-value	0.2198		0.1785	

pain. Schwartzer et al. [15] also identified pain radiation to the lower limb as being a symptom of internal disc disruption. Nakamura et al. [11] were able to relieve low back pain with radiation by selective local anaesthetic block of the L2 nerve root. The former studies [6, 7, 12] suggest that stimulation of the posterior annulus of a degenerative disc can result in leg pain. Nakamura et al. [11] in the latter study suggested that the afferent pathways of discogenic back pain lay within the lumbar sympathetic trunk. It is known that the outer layer of the normal posterior annulus is innervated and that, in degenerative discs, free pain receptive nerve endings are found deeper within the annulus [1]. Also, various inflammatory agents have been identified within the degenerative nucleus pulposus [13]. The potential for the posterior annulus to act as a pain source therefore clearly exists.

In the present study, we have shown a strong association between the presence of annular disruption and reproduction of back pain at lumbar discography (Table 2), as would be expected [8]. This finding confirms the discogenic nature of the back pain in our patient population. We have attempted to take the understanding of discogenic back pain with radiation further by identifying the discography abnormalities associated with referral of pain into the groin, hip, buttock or leg. In the study of Ohnmeiss et al. [12], no attempt was made to differentiate anterior from posterior disc disruption. The present study indicates that approximately 25% of abnormal discs will have both anterior and posterior annular tears and that approximately 8% of abnormal discs will have isolated anterior tears. In a previous study [14], isolated anterior tears were found to be associated with reproduction of back pain at discography. It has been suggested that the anterior annulus may be a source of pain radiation to the groin [10]. In the present study, isolated anterior tears were rarely associated with pain radiation, whereas a highly significant association was identified between isolated posterior annular tears and radiating pain ($P = 0.0041$). This suggests that radiating pain arises from the posterior annulus as opposed to the anterior annulus or end-plate. If the end-plate were a source of radiating pain, then it would be expected that the proportion of patients experiencing radiating pain would be similar, irrespective of whether they had isolated anterior or posterior tears. The findings, therefore, support the previous studies of McCutcheon and Thompson [6] and Milette et al. [7]. Kayama et al. [4] suggested that radiating pain may be due to the passage of inflammatory nuclear material through full thickness annular tears with a direct action on the adjacent nerve root. The presence of inflammatory tissue in the epidural space adjacent to annular tears has been documented [17]. Ohnmeiss et al. [12] were unable to assess the relationship between leak from the disc and extremity pain, since their study utilised CT discography. Full thickness annular tears are identified at discography by the demonstration of leak of contrast material through the tear (Fig. 1b), with accumulation either deep to the posterior longitudinal ligament or with free spillage into the epidural space. No significant difference was identified in the reproduction of radiating pain between partial thickness and full thickness posterior tears, indicating that radiating pain can occur in the absence of direct inflammatory stimulation of the nerve root. This is not to say that the latter mechanism does not exist.

We finally investigated the relationship between pattern of pain referral and level of disc injection. It might be expected that injection of the L1/2 or L2/3 discs would more commonly result in groin or hip pain, whereas injection of the L3/4, L4/5 or L5/S1 discs would result in radiation into the lower limb. Although this tendency was seen, it did not reach statistical significance. It is important to appreciate that pain experienced in the buttock, groin or hip can have its origins in the intervertebral disc.

A potential weakness of the present study was the inability to accurately differentiate pain radiation to the knee from pain radiation beyond the knee. However, this differentiation may not be a reliable one with respect to pain produced at discography. Milette et al. [7] found it difficult to reproduce radiating pain at lumbar discography. It has been our own experience that many patients whose radiating pain is only partially reproduced in its extent, or not reproduced at all, can develop complete reproduction of their lower limb pain several hours following the discogram. The combination of all types of pain radiation into the lower limb, for purposes of analysis, was therfore felt to be acceptable.

Conclusions

The present study indicates that a tear of the posterior annulus of a degenerative lumbar intervertebral disc can be the source of pain radiation to the groin, hip, buttock or leg, in the absence of nerve root compression. Kuslich et al. [5] showed that stimulation of the posterior annulus could result in back and buttock pain, but that sciatica was only produced by stimulation of the nerve root. Weinstein et al. [16] demonstrated an increase in substance P in the dorsal root ganglion in anaesthetised mongrel dogs following discography. This may be one of the mechanisms of pain radiation to the leg in the absence of direct involvement of the nerve root.

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